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Studies on Hevea Latex.

VII.—Rubber Derived from Preserved Latex.

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Latex preservation is now of considerable industrial importance and will become of wider interest in the future.

It has been shown that the rubber prepared from preserved latex possesses qualities different from those usually shown by ordinary smoked sheet or crepe prepared from fresh latex.

Scientific investigation is now concerned with a study of these differences and the present article is an account of investigations which have been carried out to ascertain why the rubber prepared from recently ammoniated latex vulcanises more rapidly than rubber from fresh latex.

The author concludes from his results that the rapid initial acceleration in rate of vulcanisation is not due to decomposition of the naturally occurring proteins.

It is suggested that the action of the ammonia can be explained if it is assumed that fresh latex contains a phosphatide complex which has already been suggested from physico-chemical results published in this Journal.

Introduction.

It has already been shown by the work of De Vries and Beumée-Nieuwland (1) that rubber prepared from ammoniat-

ed latex by coagulation with acetic acid exhibits a variable rate of vulcanisation which depends upon the length of time the latex has been preserved with ammonia. In recent work (2) on latex preserved with one per cent ammonia some coagulations were made with 95—97 per cent alcohol and it is of interest to compare the rates of vulcanisation of the rubber coagulated respectively with alcohol and acetic acid. In the coagulations with alcohol the ammoniated latex was dropped into four times its volume of alcohol and coagulation was instantaneous. In coagulating with acetic the coagulant was a 14 per cent acid which was added to the ammoniated latex; coagulation though not instantaneous was complete within one hour. All the coagula, were allowed to stand three to four hours before being machined to thin sheets of crepe. The crepe was thoroughly washed while being machined. It was dried under a fan without the application of heat. The times of vulcanisation are given in Tables I and II and were obtained according to the standard procedure adopted in this laboratory for the vulcanisation of rubber-sulphur mixes.*

TABLE I.

Showing Rate of Vulcanisation of Rubber obtained from Ammoniated Latex.

Sample.	Description.	Optimum Time of Vulcanisation minutes.
15A	Control. Fresh Latex. Undiluted. Acetic coagulation	190
15C	do. do. do. Alcohol coagulation	180
15D	Ammoniated Latex preserved 15 hours. do.	150
15E	do. do. 39 do. do.	165
15F	do. do. 64 do. do.	165
15G	do. do. 72 do. do.	160

* See Bull. 27, Department of Agriculture, F.M.S & S.S.

TABLE II.

Showing the Comparative Rates of Vulcanisation of Rubber coagulated with Alcohol and Acetic Acid.

Sample.	Description.	Optimum Time of Vulcanisation.	
		Alcohol Coagulation Minutes.	Acetic Coagulation Minutes.
17A &B	Control. Fresh Latex. Undiluted -	195	210
17C & D	Ammoniated Latex coagulated 30 minutes after adding ammonia -	125	205
17E &F	Ammoniated Latex preserved 24 hrs.	120	185
17G & H	do. do. do. 72 do.	120	150
17I & K	do. do. do. 120 do.	135	—
17J	do. do. do. 168 do.	145	170
389A & B	Control. Fresh Latex. Undiluted -	195	210
389C & Cx	Ammoniated Latex coagulated 30 minutes after adding ammonia -	120	190
389D & Dx	Ammoniated Latex preserved 6hrs.	120	150
389E & Ex	do. do. do. 18 do.	105	120
389F & Fx	do. do. do. 24 do.	105	120
389G & Gx	do. do. do. 48 do.	120	127
389H & Hx	do. do. do. 72 do.	120	127
389L & Lx	do. do. do. 96 do.	135	180
389M & Mx	do. do. do. 108 do.	150	180

It appeared from these results of which the acetic acid coagulations are entirely similar to those obtained by De Vries for acetic acid coagulated ammoniated latex (3), (10) that the action of the alkaline preservative had been to set

free or activate an accelerator in the latex which had been brought down with the caoutchouc-protein globules at the time of coagulation. When alcohol was added to the solution coalescence was rapid and it appeared probable that the natural accelerators were largely retained by the coagulum in its final form. When acetic acid was added to the ammoniated latex the coalescence was not so rapid and the retention of accelerators was not so pronounced. The differences in the rates of vulcanisation of the rubber at varying times of preservation are possibly due to a variation in the rates of coalescence of the ammoniated caoutchouc, it being an established fact that latex which has been preserved gives rubber with varying rates of coagulation.

De Vries has shown (1) that the rate of vulcanisation reaches its maximum at the twelfth hour following preservation of the latex. It then decreases until the original rate of vulcanisation is reached at the end of the fourth week. Subsequent to this there is a further progressive increase in the rate of vulcanisation.

To account for these changes in the vulcanising properties of the coagula it has been suggested that the proteins are hydrolysed and yield an accelerator in addition to those present in the original latex. Differences in plasticity and viscosity of the finished rubber appear to distinguish these changes from those occurring in the maturation of "slab" rubber.

Experimental.

Determination of Amide Nitrogen.—Attempts to trace the decomposition of the proteins in alkaline latex by determinations of the amide nitrogen have not provided confirmatory evidence of a gradual hydrolysis.

In the ammoniated latex used in the coagulation experiments described above, (Tables I and II) 20 gramme portions of the preserved latex, weighed in stoppered bottles, were dropped into 200 ccs. of water in a distilling flask containing magnesia. The ammonia was driven off by steam and collected and estimated in the usual manner. Two series of results are given in Table III; the figures recorded being the arithmetic means of duplicate determinations.

TABLE III.

	Period of Storage Latex and Ammonia. Hours.	Amide Nitrogen. N^3 Per Cent.
1st Series.	0.5	0.232
	24	0.286
	48	0.263
	96	0.312
	108	0.331
	204	0.267
	300	0.288
2nd Series.	0.5	0.264
	24	0.311
	48	0.294
	72	0.290
	96	0.290
	108	0.325

It was not evident from the above figures that there was any direct connection between the rate of vulcanisation of the rubber and the amount of amide nitrogen in the latex Further determinations of amide nitrogen were therefore made on latex preserved with sodium hydroxide because it was considered that if the changes in rate of vulcanisation of the rubber were due to the hydrolytic effect of the ammonia such changes would be greater by the use of a more basic alkali such as sodium hydroxide.

For these determinations the fresh latex was treated with caustic soda and immediately placed in the flasks from which the amide nitrogen was to be distilled. No attempt was made to carry out comparative vulcanisation tests. Latex within 1 hour of tapping was mixed with a concentrated solution of caustic soda so that 1000 ccs. of latex (i.e. 350 grammes of rubber) contained 20 grammes of NaOH.

Portions of 200 ccs. each were transferred to conical flasks fitted with connections for distilling into standard acid. The connections were sealed and at the appointed time it was only necessary to turn on a current of air to displace the liberated ammonia into the standard acid.

The figures recorded in Table IV show the number of ccs. of standard decinormal sulphuric acid neutralised by the ammonia derived from 200 ccs. of latex aerated after different periods of storage at 35°C.

TABLE IV.

Period of Storage. Hours.	Acid neutralised. ccs.
nil	0.6
2	0.9
6	0.9
22	1.0
28	1.0
36	1.2
nil	0.9
1	1.0
3	1.1
20	2.2
44	2.0
68	2.2

These figures are comparable with those obtained by De Vries (10) who has recently published results of an exhaustive investigation on the relation between rate of vulcanisation and the changes in ammonia content of preserved latex. De Vries shows that the ammonia content does not change for the first 3 days although subsequently there is a decrease which is rapid from the 3rd to 5th day and then very gradual.

This appears to be sufficient evidence to justify the conclusion that the hydrolysis of the latex proteins and the consequent formation of a vulcanisation accelerator is not indicated by the liberation of amide nitrogen.

Determination of Amino Acids.—Further attempts were therefore made to ascertain the nature of the change by determinations of the amino acids in preserved latex serum of different ages.

The method used for estimating the amino acids was the modification of Sorensens method of formaldehyde soda titration described by Abderhalden.*

Fresh acetic acid serum liquor was filtered and neutralised with normal caustic soda. To the neutral solution was added sufficient concentrated caustic soda solution to give the liquor two grammes of NaOH per 100 parts neutralised serum. Ten ccs. of this alkaline liquid were removed at regular intervals and neutralised with hydrochloric acid. The titrations were carried out according to Abderhalden (see below*) but the final neutralisation was made with N/100 NaOH using 1 per cent. phenolphtalein as the indicator.

Table 5 shows the number of ccs. of N/100 NaOH required for 10 ccs. of preserved serum titrated periodically after the addition of preservative. The results are the arithmetic means of duplicate determinations.

TABLE V.

Serum Period of Preservation hrs.	Volume of N/100 NaOH required to neutralise Amino Acids ccs.
0.5	14
24.0	13
72.0	17
96.0	16
120.0	16
144.0	16
Before adding preservative	19
Immediately after adding preservative	22
18 hrs.	21
42 „	24
66 „	27
90 „	29
17 days	30
47 „	31

* Abderhalden, Handbuch der Biologischen Arbeitsmethoden Abt. I. Teil .

Control titrations were carried out with serum to which known quantities of amino acids had been added: a constant volume of alkaline serum was neutralised with hydrochloric acid in the manner previously described and to separate portions of the neutral liquid definite volumes of a one per cent. solution of amino-acetic acid and a one per cent. amino propionic acid were added. The figures recorded in Table 6 are the results of duplicate determinations.

TABLE VI.

Volume of Serum + Amino acid	Volume of N/100 Na OH Required for neutralisation
	ccs.
10 ccs. serum	21.6
10 ccs. serum + 1 ccs. Amino—acetic acid solution...	36.9
10 ccs. serum + 1.5	44.4
10 ccs. serum + 2.0	52.2
10 ccs. serum	21.2
10 ccs. serum + 1.0 ccs. Amino—propionic acid solution ...	29.2
10 ccs. serum + 1.5	3.31
10 ccs. serum + 2.0	37.2
10 ccs. serum + 2.5	41.2

From which it is evident that under the conditions of these estimations 1 c.c. of N/100 NaOH is equivalent to 0.00065 grammes Aminoacetic acid or 0.00125 grammes Aminopropionic acid.

Further titrations were carried out on preserved solutions of latex proteins. Previous work had provided a means of isolating three proteins from the serum of frozen latex (4) and it was decided to ascertain the effect upon them of alkali in the strengths used to preserve Hevea latex. The proteins were mixed and dissolved in 2 per cent. caustic soda solution in the proportion of 2.1 grammes to 500 ccs. of soda solution. Portions of 10 c.c. of this solution were removed periodically, neutralised with hydrochloric acid and titrated with formalin and N/100 NaOH as already described. The figures in Table VII are the arithmetic means of duplicate titrations.

TABLE VII.

Period of Preservation	Volume of N/100 Na OH required to neutralise Amino – acids
hrs.	ccs.
Nil	6.0
24	6.4
48	5.9
72	6.0
96	6.4
after 46 days	12.0

The above results show that there is no rapid development of amino acids from the proteins of the serum solids. It remained to be seen whether amino acids would be developed in the latex.

The difficulties of obtaining a sharp end point when titrating with phenolphthalein in latex militated against very accurate results from the use of the formalin method but it was considered that, if strictly uniform conditions were adhered to, the titrations with N/100 soda solution would give an indication of any rapid change in the proportion of amino acids present. Coagulation of the latex during titration was prevented by diluting to three times the original volume and neutralising the alkaline latex very slowly. Eight hundred and fifty ccs. of fresh latex (†) were treated with twenty grammes of NaOH dissolved in 150 ccs. of water, mixed thoroughly for five minutes and portions of 15 ccs. each removed and diluted with 30 ccs. of water preparatory to titrating. The alkali was acidified to phenolphthalein by titrating with N/2 HCI, the final adjustment to neutrality being made with N/100 NaOH. Five ccs. of neutral formalin solution were then added and the latex titrated with N/100 NaOH. Table VIII gives some typical results obtained from duplicate or triplicate titrations after different periods of storage. The figures recorded for the control titrations on fresh latex are those calculated from the results obtained for the titrations of undiluted latex at the time the alkali was added.

† Dry rubber content approximately 35 per cent.

It is relevant here to direct attention to the sharp differences in the behaviour of the alkaline latex at the time of neutralisation with acid. Freshly alkaline latex when diluted and neutralised with acid shows no tendency to coagulate as the acid is added. If the alkali has been mixed wtih the latex for more than six or seven hours it becomes increasingly difficult to neutralise with even a dilute acid and prevent incipient coagulation. It is significant that this change in coagulation phenomenon is not apparent until after the latex has stood for some hours.

TABLE VIII.

Period of Preservation.	Volume of N/100 Na OH required to neutralise Amino Acids.
	ccs.
Fresh latex without soda ...	12.2
Alkaline latex immediately after treatment ...	14.4
After 3 hours ...	16.9
„ 6 „ ...	15.8
„ 24 „ ...	15.6
„ 30 „ ...	16.0
„ 48 „ ...	16.0
„ 7 days the latex was too thick to measure accurately by volume	
Fresh latex without soda ...	15.3
Alkaline latex immediately after treatment ...	16.3
After 1 hour ...	12.0
„ 1.5 hours ...	11.2
„ 3.5 „ ...	16.4
„ 4.0 „ ...	17.0
„ 28.0 „ ...	17.0
„ 140.0 „ ...	19.0
Fresh latex without soda ...	15.6
Alkaline latex immediately after treatment ...	18.5
After 5 hours ...	17.5
„ 24 „ ...	18.4

Discussion.—A study of the foregoing results does not indicate any rapid development of amino acids which might

account for the rapid initial acceleration in the rate of vulcanisation of rubber prepared from alkaline latex.

In the results published by De Vries it is shown that the time of vulcanisation changes from 110 minutes to less than 80 minutes in the first 4 hours that the latex is under the influence of the ammonia. In the investigations carried out at the Department of Agriculture the greatest acceleration was from 195 minutes to 120 minutes in 6 hours. It is therefore obvious that the change is rapid and from the foregoing, would appear to be of a more profound character than one would be likely to associate with the initial hydrolytic action of a comparatively dilute alkaline solution on proteins such as those already isolated from Hevea latex.

If the rapid change in rate of vulcanisation is not due to the liberation of accelerators from the proteins it becomes of increased importance to speculate on other possible explanations.

A consideration of the coagulation phenomena observed with fresh latex led Belgrave (6) to suggest the presence of a thermo-labile substance of the lipin type. Although chemical investigation has so far failed to isolate such a body it has been possible to separate from latex a waxy substance similar to lecithin and there are indications that this phosphatide occurs in close association with the protein and caoutchouc (5) possibly in the form of an adsorption complex. It appears permissible at this stage to argue that the existence in fresh latex of a complex such as that predicted by Belgrave (6) would provide an explanation for the changes in vulcanising properties of rubber prepared from latex to which a dilute alkali has been added prior to coagulation.

Some observations on the vulcanising properties of rubber prepared by the coagulation of latex with alcohol of different pH values have already been recorded (7) while Whitby (8) and more recently Van Rossem and Dekker(9) have published results sowing the possible effects on raw rubber of the oxidation of the constituent fatty acids. Their results appear to have still further significance if fresh latex contains a labile phosphatide complex.

The writer wishes to record his thanks to Mr. B. J. Eaton and Mr. W. N. C. Belgrave for valuable advice and suggestions.

Summary.

Results are recorded for the variations in rate of vulcanisation of rubber prepared from latex preserved for varying periods. These results agree with those already published by other investigators.

Results are given for estimations of amide nitrogen and amino acids in preserved latex and preserved latex serum. Since these do not show an increase commensurate with the variations in rate of vulcanisation of the rubber it is suggested that hydrolysis of proteins is not responsible for the development of accelerators in preserved latex

A suggestion is therefore made that the initial effects observed in the rubber from alkaline latex constitute a reason for assuming the existence in fresh latex of a labile complex which is affected by a change in the hydrogen ion concentration of the latex.

If, as already indicated by previous work, this complex embraces a phosphatide it is probable that the variation in rate of vulcanisation of rubber from alkaline latex is related to changes in the fatty acid constituents.

References.

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Variation in Plantation Rubber.

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In connection with the question of variability in plantation rubber it is of interest to record here some results which have recently been obtained from the examination of a collection of rubber from Malayan estates.

Samples of not less than 5 lbs. were taken from cases of exhibits displayed at the Malayan Exhibition held in Kuala Lumpur, under the auspices of the Malayan Agri-Horticultural Association and at the Lower Perak Agri-Horticultural Show held at Telok Anson.

The samples were representative of some of the best estate rubber now being produced.

The examination consisted of preliminary vulcanisation tests to ascertain the optimum time of vulcanisation at 140°C of a 90 : 10 rubber sulphur mix, according to the usual procedure adopted in the laboratories of the Department of Agriculture.

Further mixings of the samples were then vulcanised at the optimum time and tested for mean tensile strength on a Schopper testing machine.

The tables below give the optimum times of vulcanisation, the mean loads at break, elongations, and tensile product figures for at least 12 test pieces in each case.

The awards of the judges at the exhibitions are included. In making their selections the judges were influenced by the general appearance and finish of the rubber, freedom from blemishes such as shortness and opaque streak. All the samples were practically first class with regard to the usual superficial characteristics.

The symbol B/L indicates breaking load. The tensile product represents the breaking load per square m.m. at the point of break, assuming that the cross section of the sample is reduced proportionately to the elongation at break.

Table I.

Smoked Sheet.

Reference No.	Colour of Sheet.	Time of Vulcanisation Minutes.	No. of Tests.	Mean Tensile Strength Bil. Kgs. per Sq. in. a.	Mean Elongation at Break. Original Length 100. b	Mean Tensile Product.	Coefficient of Deviation from Mean Bil. per cent.
				(*a*)	(*b*)	($a \times b$)	
393 A	Medium *	213	14	1.33	1010	1343	5.3
393 B	do.	165	12	1.33	1042	1385	9.9
393 C	Light	225	12	1.32	1039	1371	2.5
393 D	Medium	180	15	1.38	1046	1443	5.5
393 E	do. *	210	15	1.32	1029	1538	6.6
393 F	Dark	195	16	1.43	1038	1484	3.4
393 G	Medium	210	16	1.39	1046	1453	5.1
393 H	Light *	240	14	1.44	1033	1487	5.5
393 J	Medium	195	14	1.40	1044	1061	5.7
393 K	Dark	195	14	1.38	1040	1435	13.0
393 L	Medium	195	14	1.16	1019	1182	10.6
393 M	do.	210	12	1.27	1067	1355	6.5
393 N	do. *	165	16	1.19	1059	1260	10.6
393 O	Light	165	14	1.32	1036	1367	4.2
393 P	Medium	195	12	1.37	1036	1419	7.5
393 R	Dark	195	11	1.29	1051	1355	4.2
393 S	Medium	165	14	1.41	1049	1479	5.4
393 T	do.	195	14	1.47	1041	1330	3.2
393 U	Dark *	225	12	1.26	1044	1515	5.3
393 W	Light	210	16	1.38	1067	1478	5.8
393 X	do.	165	16	1.43	1051	1503	5.5
393 Y	do.	210	10	1.42	1049	1489	2.9
393 V	do. *	195	14	1.37	1061	1453	3.4
393 Q	Medium *	195	16	1.39	1047	1455	5.3

* Prize winners at the M.A.H.A. Exhibition.

Table II.

Pale Crepe.

Reference No.	Description.	Time of Vulcanisation Minutes.	No. of Tests.	Mean Tensile Strength B.I. Kgs. per Sq. in.	Mean Elongation at break. Original Length 100.	Mean Tensile Product.	Coefficient of Deviation from Mean B.I. per cent.
				(*a*)	(*b*)	($a \times b$)	
394 A	Thin Crepe Pale Colour	180	17	1.23	1032	1269	6.8
394 B	Medium Crepe Pale Colour	232½	14	1.15	1003	1153	9.7
394 C	Thin Crepe Pale Colour	225	15	1.24	1024	1269	9.0
394 D	Medium Crepe Pale Colour*	195	14	1.39	1027	1427	4.4
394 E	Thin Crepe Pale Colour	210	15	1.37	1020	1397	5.9
394 F	Thick Crepe Yellow Colour*	195	16	1.41	1029	1450	6.0
394 G	Thick Crepe Yellow Colour	195	12	1.35	1049	1416	10.2
394 H	Medium Crepe Yellow Colour*	195	12	1.42	1017	1443	9.0
394 J	Thick Crepe Yellow Crepe	195	16	1.44	1026	1477	4.06
394 K	Medium Crepe Yellow Crepe*	232½	14	1.30	1023	1329	5.0
394 L	Medium Crepe Pale Crepe	210	16	1.30	1019	1324	7.2
394 M	Thick Crepe Yellow Colour	210	15	1.37	1043	1428	4.5
394 N	Medium Crepe Pale Crepe*	210	12	1.28	1036	1326	10.0

* Prize winners at the M.A.H.A. Exhibitions.

Table III.

Compo Crepe.

Reference No.	Description at M.A.H.A. Exhibition.	Time of Vulcanisation Minutes.	No. of Tests.	Mean Tensile Strength Bft. Kgs. per Sq. in. (a)	Mean Elongation at Break, Original Length 1in. (b)	Mean Tensile Product. (a × b)	Coefficient of Deviation from Mean B.L. per cent
395 A	-	150	16	1.34	1038	1390	4.8
395 B	*Highly Commended* -	157½	13	1.31	1045	1368	4.6
395 C	-	180	16	1.37	1019	1396	6.2
395 D	-	165	18	1.32	1037	1368	6.7
395 E	*2nd Prize* -	165	18	1.35	1037	1400	5.2
395 F	*3rd Prize* -	165	18	1.41	1026	1440	5.5
395 G	*1st Prize* -	165	18	1.24	1040	1286	4.2
395 H	-	180	16	1.38	1030	1421	5.7
395 J	-	150	16	1.34	1037	1389	7.7
395 K	-	172½	14	1.37	1044	1430	3.9
395 L	*1st Prize* (Lower Perak)	180	16	1.35	1020	1517	9.3

Table IV.

Unsmoked Sheet Exhibited by Small Holders.

396 A	Medium Colour - *1st Prize.*	210	5	1.28	1038	1328	7.9
396 B	Medium Colour - *2nd Prize.*	165	11	1.29	1084	1398	5.7
396 C	Medium Colour - *3rd Prize.*	210	6	1.34	1045	1400	3.9
396 D	Medium Colour - *3rd Prize.* (Lower Perak)	150	16	1.32	1041	1374	7.6

Remarks and Conclusions.

The chief feature is the large variation in rate of vulcanisation shown by some of the samples, particularly smoked sheet from different estates, indicating probably a considerable variation in methods of preparation. Fifteen of the samples of smoked sheet vary however by only 15 minutes—from 195 to 210 minutes while nine of the samples of pale crepes show a similar variation.

The variation in the compo crepes is probably due to the proportion of "lump" included in this grade.

Smoked Sheet Samples.—The classification of the samples by the Judges at the Malayan Exhibition are shown in Table I, in respect of the 1st, 2nd and 3rd prizes and highly commended samples and are also given below.

The order of merit according to the result of the vulcanisation tests and according to the judging at the Malayan Exhibition is as follows: —

Order of Merit.

Results of Vulcanisation Tests		By Judges at the Exhibition	
1st	X	1st Prize	A
2nd	S	2nd „	U
3rd	B, O	3rd „	H
4th	D	Highly Commended	E
		Highly Commended	N

All the samples are of excellent quality in respect of tensile strength, after vulcanisation by the standard method.

The chief feature however is the remarkably slow rate of vulcanisation of the majority of the samples.

Normally, smoked sheet vulcanises in $2\frac{1}{2}$ to $2\frac{3}{4}$ hours (150—165 minutes) under the procedure of vulcanisation adopted.

It will be seen however that nineteen of the twenty four samples have an optimum time of vulcanisation varying from 3—4 hours (180—240 minutes) including eighteen samples which vary from 195 to 240 minutes.

No reason can be given for this slow rate of vulcanisation. The replies received from nineteen estates show that seventeen of the estates use acetic acid as a coagulant and two use formic acid. The two samples from estates using formic acid have the slowest rate of vulcanisation, which may be due to impurities (such as formalin) in the coagulant.

Since nearly all the samples are of excellent tensile strength after vulcanisation, the order of merit on the vulcanisation tests is based on the rate of vulcanisation, higher marks being awarded to samples which vulcanise more rapidly, other qualities being equal.

Pale Crepes.—The classification of the samples of pale crepe based on the results of vulcanisation tests and as judged at the Exhibition is as follows:—

Order of Merit.

Results of Vulcanisation Tests		By Judges at the Exhibition	
1st	J	1st Prize	D
2nd	H	2nd „	K
3rd	F	3rd „	H
4th	D G	Highly Commended	F

On the results of vulcanisation tests, there is little significant difference between all the above five samples. They all vulcanise at the same rate and the difference in tensile strength is very small. It will be seen that the order of merit on the results of the vulcanisation tests includes three of the samples awarded at the Exhibition.

Nearly all the samples of pale crepe are of excellent tensile strength after vulcanisation. The optimum time of vulcanisation varies from 180 to 232 minutes and most of the samples vary from 180 to 210 minutes, which is normal for this grade of rubber.

Compo Crepes.—The order of merit according to the result of the vulcanisation tests and according to the judges at the Exhibition is as follows:—

ORDER OF MERIT.

Results of Vulcanisation Tests		By Judges at the Exhibition	
1st	J	1st Prize.	G
2nd	A	2nd ,,	E
3rd	B	3rd ,,	F
4th	D, E, F	Highly Commended	B

There is very little difference in tensile strength in any of the above six samples and the order of merit is therefore based on the rate of vulcanisation. It will be seen that three of the samples awarded at the Exhibition are included in the awards, as judged by the results of vulcanisation tests. These samples of compo crepe are all equal in quality to the samples of smoked sheet and have generally a more rapid rate of vulcanisation.

Unsmoked sheet exhibited by small holders.—Only four samples of sheet exhibited by small holders were collected. These are of excellent quality and equal in quality to the samples of sheet from the large estates.

On the vulcanisation tests there is no significant difference in tensile strength after vulcanisation between these three samples. The best sample is Ref. No. 396 D prepared on a Chinese Estate, which has a normal rate of vulcanisation of 2½ hours (150 minutes).

SUMMARY.

The figures show that the best plantation rubber varies considerably in rate of vulcanisation, although there is uniformity in the tensile properties of the vulcanised product.

These results confirm the opinion expressed by F. B Jones of the Dunlop Rubber Coy. (I.R.J. Vol. 72 No. 19. 1926 p. 19).

On the other hand de Vries (I.R.J. Vol. 73 No. 8. 1926 p. 13) gives results indicating a considerably greater uniformity between rubber from different estates in Java and Sumatra.

Abnormalities in the Coconut Palm.

W. N. Sands.

In the Gardens Bulletin, Straits Settlements, Vol. III (1924) page 274 and also in Vol. IV (1927) page 78, there were published articles by C. X. Furtado concerning certain abnormalities in the coconut palm, e.g. the branching of the stem; polyembryony; the development of usually abortive male flowers; albino seedlings; horned coconuts and the suppression of spikelets in coconut spadices. It may be of interest to supplement the information contained in the above named articles by a few notes on other curious forms which have been observed in Malaya.

With reference to the palm producing the unbranched type of inflorescence described by Furtado, this is known locally as "Niyor Kelubi" because the female flowers are closely packed together on the spadix like those of the "Asam Kelubi" palm (*Zalacca conferta*, Grff.) (Plate 1, fig. I.).

In a kampong near Sungei Gedong Estate in Perak there is a tall palm, about 30 years old, termed the Pinang coconut, for like the Pinang or Areca-nut palm (*Areca Catechu* L.), the leaflets of each leaf are confluent, that is, they are joined together along their margins. The leaflets are not all joined, but on every leaf there are groups of 2, 3, 4 or 5 firmly stuck together in lengths varying from 3 to 20 inches along a total length of 45 to 48 inches. The basal portions of the leaflets, however, are always free. It was observed that the 'Pinang' character persisted even in perfectly dry leaves which had been shed naturally. The owner of the palm stated that this abnormality had been noticeable from the time the palm was planted. (Plate 1, fig. 2.).

Perhaps the most striking abnormal palm, of which several specimens have been seen, is one known in the Krian district of Perak as "Niyor Sa'ratus." It belongs to the dwarf race and fruits at the age of 3 to 4 years. The name Sa'ratus is given to it because it produces about 100 fruits on each spadix from a still larger number of female flowers. The coconuts vary considerably in size; those apparently more favourably placed on the spadix being larger than the others. The

largest fruits measure about 7½ inches long and are elliptical in shape. The nuts are oval about 3¼ inches long and 3 inches wide with thick endosperm. The smaller fruits which comprise the majority, often resemble in size and shape a fair-sized cucumber. The fruits on one mature tree which was at least 25 years old were counted, and on 10 spadices there were 960 fruits or an average number of 96 fruits per spadix. The larger fruits are certainly viable, and the Malays say that they breed true, this, however, is doubtful because in one particular kampong where two seedlings from a certain tree had been planted one was certainly typical Sa'ratus, whilst the other appeared to be a hybrid with an ordinary tall form as it was producing far fewer and larger fruits on a tall palm. The shells of the small nuts of the typical Sa'ratus type are much sought after for the manufacture of small table ornaments and domestic utensils (Plate II.).

Another remarkable freak coconut of which there are specimens in Perak, and probably elsewhere, resembles the form termed by Ridley (1) a 'bulbilliferous' coconut. Ridley states that the tree he described was found at Lumut in the Dindings. It resembled an ordinary coconut except that its foliage was thicker and it had never borne fruit. About 5 years previously when the palm should have started bearing it put out deflexed shoots instead of flower spathes. The shoots grew to a length of 4—5 feet before they fell. The whole appearance of the shoot was like an ordinary young coconut. Again Burkill (2) described two young abnormal coconut palms growing in the Cocos Keeling Islands which he considered showed the unusual characters mentioned by Ridley. He remarked that it was not recorded in regard to these Cocos Islands palms whether the branches fell off or persisted. The abnormal condition was due to the foliation of the bracts of the inflorescence so that the inflorescence was turned into a leafy branch; it was also sterile. The persistence of such a shoot would, he considered, lead to the rare occurrence —a permanently branched palm; on the other hand, if the branches fall off, as is almost certainly the case, the duration of their persistence should be noted as it is possible that they hold in their places as if they were inflorescences just as long as their nuts would have taken to mature had they been fertile.

The following additional information concerning this peculiar type of palm has recently been obtained. The two

palms from which pseudo-spathes and shoots have been examined are growing on Rungkop Estate in Perak. The palms are a good distance apart and one of them is a particularly fine tall specimen. They have never produced any nuts, but only branches. At first the shoot resembles closely in size and appearance an ordinary spathe, (Plate III fig. B.), but when it is dissected it is found to consist of several sheathing bracts which gradually merge into normal leaves. The two outermost bracts are quite entire, the next usually shows rudimentary leaflets near the apex, whilst the succeeding ones up to nine in number become more and more like normal leaves as the centre is approached. As the shoot develops, the stem grows at first in a downward direction and then turns upwards to become crescent-shaped. It is surmounted by a crown of healthy leaves which are often ten feet long. (Plate III fig. A.). A few short roots are sometimes thrown out of the side of the branch close to the trunk of the main stem.

The stem of an old branch is usually about 1—1½ feet long and up to 5 inches in diameter. It is constricted at the base so that at the place where it is attached to the main stem it is only about two inches in diameter. Whilst the above is a description of the usual form of a branch, still one was seen which had produced a short, almost straight stem 2 feet 6 inches long with the recurved thickened portion at the distal end of it: this peculiar type of growth, however, appeared to be exceptional. (Plate III fig. D.).

The branches of this 'bulbilliferous' palm may remain for several years on the tree, often at some distance below the crown of leaves, and only fall when the vascular strands connecting the branches with the main stem are unable to support their weight. One large healthy shoot which was still attached to the trunk weighed just over 20 pounds. The branches in this type of palm, therefore, do not persist to form a permanently branched palm such as has been described by other writers.

References.

1. H. N. Ridley — 'Branching in Palms'. Annals of Botany Vol. XXI (1907) page 415.

2. I. H. Burkill — 'An Abnormality in the Coconut Palm'. Journal Royal Asiatic Society (Straits Branch) No. 69 (1915) page 15.

Explanation of Plates.

Plate 1, fig I. An unbranched spadix and full grown fruit from the 'Niyor Kelubi' palm.

Plate 1, fig 2. A portion of the leaf of the 'Pinang' coconut palm showing the manner in which the leaflets are joined together.

Plate 2. A 'Sa'ratus' palm with 10 spadices bearing 960 fruits.

Plate 3. Branches of the 'bulbilliferous' coconut, (A) A typical branch several years old, (B) An unopened shoot. (C) A shoot commencing to open and (D) An abnormal branch with a long stem.

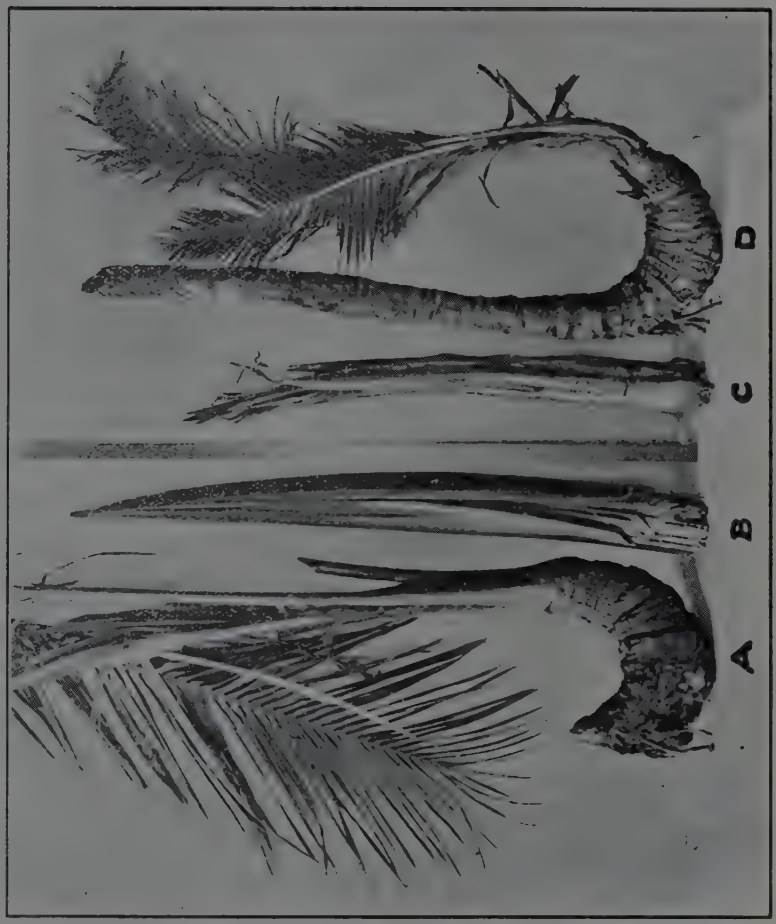
Fig. 1.

Fig. 2.

PLATE I

PLATE II

PLATE III



A Note on the Methods of Destroying Dead Coconut Palms.

F. R. Mason.

Dead coconut palms, whether standing or lying about, on estates or small holdings, are always a source of danger to living palms in the same locality, as they rapidly become suitable breeding grounds for the "Black" or "Rhinoceros" Beetle (*Oryctes rhinoceros*), a pest which is capable of seriously damaging palms of almost any age, if allowed to remain uncontrolled for any length of time. For this reason all dead palms, whether death was due to natural causes or deliberate felling, should be disposed of as soon as possible.

There are two methods of destruction in common use.

(a) *Burying.*—The trunks of dead palms are cut up into lengths of about 6 feet and buried, the stumps, which should always be uprooted, being treated in a similar manner. It has been found necessary to insist on the burying of dead trunks and stumps to a depth of 3 feet in average soil, though in sandy soil burying to a depth of 2 feet may be allowed. The reason for this is to prevent the access of beetles on an egg-laying expedition, and also to prevent newly emerged beetles from gaining liberty, should they have been present in the form of pupae or larvae when the log was buried.

This method of destruction is not to be recommended for two reasons. It needs careful supervision to see that the burying is always carried out to the required depth. Also, it has been found that buried coconut wood is detrimental to the health of succeeding crops, especially if the latter be rubber, since the decaying logs become infested with two or three of the fungi causing root diseases of rubber and other plants. In Province Wellesley and Krian two or three large estates have, in the past, cut out areas of old coconuts, burying the stumps and trunks *in situ* and afterwards replanting the area with rubber. As the rubber trees were nearing maturity, a large number of cases of root disease developed among them, the infected roots being traced in all cases to the decaying coconut logs in the soil. So numerous were the cases of root disease that, in three instances, it was found necessary to dig up all the old coconut wood and dispose of it by other means. (Agric. Bull., F.M.S., Vol. VI, p. 269).

(b) *Burning.*—This is by far the most satisfactory method of disposing of dead palms since, provided it is carried out thoroughly, it ensures complete destruction. When advocating this method, the writer has constantly been met with the reply that burning is easier said than done, that it costs a lot of money, and can only be carried out after long periods of dry weather. Burning dead palms is not a difficult task provided it is undertaken systematically and in the correct manner. One often sees a considerable number of palms felled in one area, either as a result of disease or to make way for other crops. The usual method of destroying them is to cut up the stems into lengths of 4 or 5 feet, split them, and pile them in small heaps for drying. (See fig. 1). When the wood is thought to be sufficiently dry, an attempt is made to fire each pile as it stands. More often than not failure results and the wood is merely charred and left to decay naturally. The use of kerosene or tar does not greatly increase the effectiveness of the fire and is expensive.

During recent years large areas of coconuts in Province Wellesley have become old and useless and in many cases the land has been rendered unsuitable for further planting with this crop. Permission having been obtained, many of these areas have been felled and the land subsequently planted with rubber. The problem of destroying the felled palms immediately presented itself. After numerous attempts it was discoverd that the following method was the most effective.

The secret of effective burning lies in the building of really large bonfires and in their careful construction. The felled palms, the stumps of which should be entirely uprooted, are cut into lengths of 4—5 feet and conveniently stacked for drying; splitting the stems is not essential, although it facilitates drying. When moderately dry, a number of stumps are placed in two rows, parallel to one another and about 2—3 feet apart. This is to form a kind of flue. Lengths of trunk are placed, as close together as possible, across the space between the rows of stumps, so forming a roof to the flue. On the top of these and around the stumps should be placed other lengths of trunk, split or unsplit, laid lengthwise and closely compacted. Any number of lengths of trunk may also be piled on the top, so long as they are all placed the same way and close together (See fig. 2). Logs should never be built up criss-cross fashion with the idea of allowing for circulation of

air. This is unnecessary and, in fact, causes the fire to burn through so quickly that most of the wood is merely scorched.

To start the fire, the flue should be filled with really dry material such as palm leaves, dry fruit branches and any odd pieces of stick or fibre lying about. It is better to fill the "flue" with this material before it is covered on top. If circumstances allow, a few odd lengths of dry rubber wood or other timber should be introduced into the "flue". This gives the fire a much better chance to get a hold. The whole secret is to induce a large body of heat in the centre of the pile. Once this is obtained the fire will continue to burn for hours, even a couple of days, if the pile has been properly built, and should burn through an average rainstorm.

This method of burning has been carried out with great success on two large Estates in Province Wellesley. In one case an area of 250 acres of felled palms was treated by the method described above. Despite the fact that rubber had been planted at stake before burning took place, over the whole area only six seedlings, which were then 1—2 feet high, were injured by scorching. Adequate protection was, of course, given to all young seedlings within range of the bonfire.

By the use of the same method at the Talang Experiment Station, Kuala Kangsar, the Agricultural Field Officer, Perak North, had no difficulty in burning 52 very large old coconut palms recently felled. The stack was built under his personal supervision and was lighted at 6.30 a.m. The fire took hold well and by noon was so hot that it was not possible to place any more material upon it. It is, therefore, desirable to make as big a stack as is conveniently possible, before setting fire to it.

The writer is indebted to the Managers of the two Estates on which successful burning was witnessed for information regarding the method described in this note and for their permission to publish it.

Note.

Major B. J. Eaton, O.B.E., F.I.C., F.C.S. was elected a Fellow of the Institution of the Rubber Industry, on May 13th 1927.

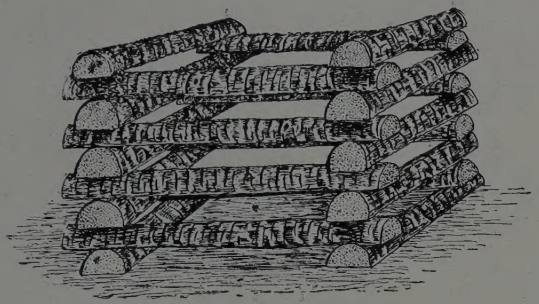


Fig. 1.

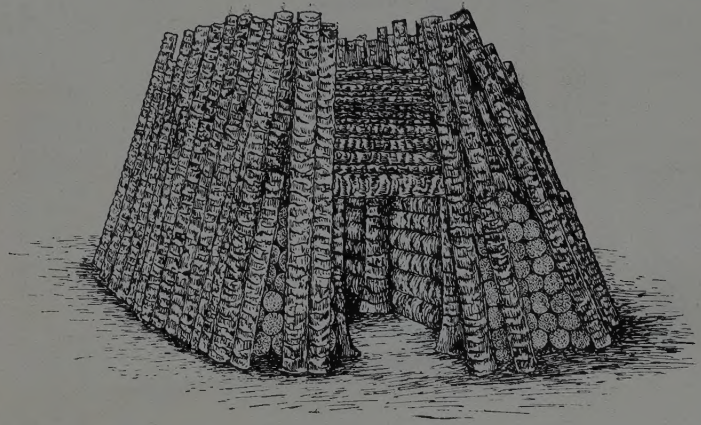


Fig. 2.